Fluctuations of Populations of *Lygus hesperus* Knight in California Alfalfa Fields
(Hemiptera: Miridae)

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Fluctuation is an outstanding characteristic of populations of insects and an understanding of the nature of the fluctuation and the factors causing it is fundamental to the prediction of population growth and decline. For example, increases in populations on preferred host plants may be reflected by migrations of adults to less preferred hosts. Thus, *Lygus* spp. build up on alfalfa in the spring and migrate to cotton during the summer as the alfalfa is cut or becomes mature (Stern et al., 1967). As a result, population studies of lygus bugs have centered on alfalfa as the primary source of the infestation in cotton.

Recent investigations of *L. hesperus* Knight in Arizona alfalfa fields have remarked on a relatively uniform increase and decrease in the adult populations each year (Butler and Wardecker, 1970). It was therefore of interest to consider the populations of lygus bugs in California to derive a possible cause of the rate of change in both Arizona and California. Smith and Hagen (1966) studied populations of alfalfa aphids and other insects in 51 alfalfa fields distributed through several climatic districts of middle lowland California throughout the year and in many fields for several consecutive years. They assessed the local climate of each field in terms of relative humidity, temperature, and rainfall. These investigators made the data on lygus bugs and conditions available for the analytical study reported here.[1]

Methods and Materials.—The number of lygus bug adults per 100 net sweeps from the weekly samples of either 2, 5, 10, or 100 net sweeps was calculated from individual fields reported by Smith and Hagen (1966) and weekly totals were obtained for the San Joaquin Valley and for the Salinas Valley in 1957, 1958, and 1959. Then regression equations, $\hat{y} = a + bX$, where $\hat{y}$ is the logarithm of the number of lygus bugs per 100 net sweeps and X is the day of the year, were calculated for each valley and year. The equation used is the linear expression of the classical formula describing the curve of geometric increase of an infinitely expanding population. The rate of increase is

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TABLE 1. Regression equations for the rate of increase of adult lygus bug populations in alfalfa in California.

Location	Year	No. Fields	Dates	n	Regression Equation[a]	r^2
San Joaquin	1957	11	17 April –9 July	11	–0.2745 + 0.0152X	.82
	1958	10	2 April –1 July	13	–2.2314 + 0.0265X	.81
	1959	9	10 March–8 July	18	–0.8310 + 0.0180X	.86
Salinas	1957	8	30 April –9 July	10	–0.1795 + 0.0152X	.76
	1958	6	10 April –1 July	11	–1.9066 + 0.0253X	.92
	1959	2	16 March–8 July	16	–0.7287 + 0.0192X	.74

[a] Regression equation $\hat{y} = a + bX$, where $\hat{y}$ is the logarithm of the number of adult lygus bugs per 100 sweeps and X is the date.

also equivalent to the term r_m "the innate capacity for increase" used by Andrewartha and Birch (1940:35) which "is the only statistic which adequately summarizes the physiological qualities of an animal which are related to its capacity for increasing."

Results and Discussion.—Regression equations for the rate of increase of adult lygus bugs in the San Joaquin and Salinas Valleys from April to July 1957 and 1958, and from March to July 1959 are shown in Table 1. The rates of increase or "b" in the two areas are very similar for each of the three years at both locations. The lowest rate occurred in 1957 and the highest in 1958. Also, the tests of the homogeneity of the regression coefficients indicated that the rate of increase in 1958 differed from that in 1957 and 1959, and that the rates in 1957 and 1959 were similar. These rates in 1957 and 1959 are also similar to the values (average "b" of 0.016) determined for other years in Arizona (Butler and Wardecker, 1970).

Since the rates of increase in the two areas were similar in 1957, 1958, and 1959, the results for each year were pooled. Then, a comparison was made between the pooled results in which the average rate of increase for 1957 + 1959 was compared with that for 1958. A significant difference between the slopes (or rates) was obtained ($F = 11.28$, 75 df, $P = > 0.99$).

Analyses of the average mean monthly temperatures showed that during March and April 1957 and 1959 temperatures were higher than those in 1958. May temperatures were higher in 1958 than in the other years. Since threshold temperatures for the development of different stages of *L. hesperus* are about 45° C (Butler and Wardecker, 1971), the average monthly temperature above this threshold was determined and regression equations were calculated for the monthly increase from

TABLE 2. Rate of increase and decrease of average monthly temperatures in Arizona and at two sites in California.

Location	Year	Period of Increase March to July		Period of Decrease July to November	
		b[a]	r^2	b[a]	r^2
Arizona					
Casa Grande	1967	0.0035	.95	–0.0032	.88
	1968	0.0038	.97	–0.0034	.88
California					
Salinas					
Valley	1957	0.0032	.97	–0.0041	.75
	1958	0.0056	.85	–0.0029	.64
	1959	0.0037	.96	–0.0043	.74
San Joaquin					
Valley	1957	0.0048	.94	–0.0053	.80
	1958	0.0073	.84	–0.0042	.72
	1959	0.0037	.96	–0.0045	.78

[a] From the regression equation $\hat{y} = a + bX$, where $\hat{y}$ is the logarithm of the mean monthly temperature minus 45°F, and X is the date.

March to July (Table 2). The rates of increase in temperatures in 1957 and in 1959 were similar in both areas and tests of the homogeneity of regression of those slopes showed that they followed a similar pattern to those observed for the increase of lygus bugs. Also, the pooled values for 1957 and 1959 were significantly different from those for 1958; therefore, the temperature increase was different during the 1958 season. The increase in temperature and in population of lygus bugs thus had a correlation coefficient of 0.881 (6 df, $P = > 0.99$), indication of an association between the increase in number of lygus bugs and the increase in the average monthly temperature.

One of the unique characteristics of the population of lygus bugs in Arizona is the rate of increase in the spring being so similar to the rate of decrease in the fall. No such uniformity was observed in California. Again, an explanation can be found in the temperatures. The average monthly rate of increase in temperatures in the spring in Arizona is very uniform and the decrease in the fall is very similar. In California, where hot weather often occurs in August and September, the rate of decrease differs and shows less conformity to a linear decline. Reproductive diapause (Beards and Strong, 1966) also affects the numbers present in the fall.

Conclusions.—The average rates of increase in the number of adult *L. hesperus* in alfalfa in two areas of California in 1957 and 1959 were similar to the average yearly rate of increase observed in Arizona. However, in 1958, March and April were relatively cool, while May temperatures were high. This caused a marked acceleration in the rate of increase. Although uniformity in the buildup of lygus bugs is being stressed in current studies, the number in a given population is in a state of oscillation.

In Arizona, increases and decreases in the average monthly temperature during the spring and fall are relatively uniform which causes a corresponding uniform fluctuation in the population of adult lygus bugs. Although there are numerous factors affecting the fluctuation in population of lygus bugs, heat input and temperature extremes play a dominant role.

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BOOK REVIEW

An English-Classical Dictionary for the Use of Taxonomists. Compiled by Robert S. Woods. Pomona College, Claremont, California 91711. xiv + 331 pp. 1966. $5.50.

This is the perfect companion to the scholarly Roland W. Brown's *Composition of scientific words.* It is a listing of "all words found in unabridged classical Greek and Latin lexicons which could conceivably be used in scientific nomenclature, including those which would be applicable only in a metaphorical sense." Because the alphabetized words are in English, in boldface capitals, it is easy to use, and full of suggestions for the student wanting to choose a name for a new taxon. After each term the Greek and Latin words are given; at this point one refers to Brown's book or to a dictionary for restricted meanings and details. Every page contains a number of words not in Brown, or found there only by patient searching. Mr. Woods' book deserves much wider advertising than it has had.—Hugh B. Leech, *California Academy of Sciences, San Francisco.*